

Effect of Induced Fatigue of Unaffected Limb on Balance in Children with Hemiplegia

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Abstract

Background: Children with hemiplegic cerebral palsy bearing weight mostly through the unaffected leg and may be a strategy to compensate for muscle paresis in the hemiplegic leg causing fatigue of unaffected limb and impaired balance.

Aim: To determine the immediate effect of induced fatigue of unaffected limb on balance in children with hemiplegic cerebral palsy.

Patients and Methods: 29 children with hemiplegic cerebral palsy (8.9 ± 2.3 years). Before and after induced fatigue of unaffected limb the balance were recorded by Biodex balance system.

Results: There were significant difference before and after fatigue in balance overall stability index ($p < 0.001$), anteroposterior stability index ($p = 0.003$), mediolateral stability index ($p = 0.002$).

Conclusion: Fatigue of unaffected limb deteriorates balance in children with hemiplegia.

Key Words: Fatigue – Balance – Hemiplegic cerebral palsy.

Introduction

CEREBRAL Palsy (CP) describes a group of disorders of posture and movement that occur as a result of a non-progressive disturbance in the developing fetal or infant brain [1].

Impaired postural control in children with CP has been shown to result from multiple factors: Musculoskeletal problems, including contractures, reduced range of motion, and shifts in initial alignment, all affect reactive balance control in children with CP [2].

Children with hemiplegia about 33% of children with cerebral palsy which is characterized by one side brain affection that causes weakness and

spasticity contralateral to the affected brain hemisphere [3].

Children with unilateral CP tend to have impaired coordination of movement, reduced between-limb synchronization, and less weight bearing on the affected side, which in turn can affect the ability to maintain an upright weight-bearing position as well as gait [4].

Balance defined as the act of maintaining, achieving, or restoring the center of mass relative to the base of support [5]. The maturation of balance skills in children with cerebral palsy is also known to be delayed or diminished when compared to typically developing children [6]. Due to the musculoskeletal asymmetry in children with hemiplegic CP, all balance parameters show significant differences when compared with those of typically developing children [7].

Fatigue can be defined as the inability to maintain a power output during or following a repeated muscular contraction [8]. Muscle fatigue can influence the various mechanisms that regulate balance. Studies in young people show that muscle fatigue in the lower limbs increases postural sway [9], so this study concerned about the effect of unaffected limb fatigue on balance in hemiplegic children.

Patients and Methods

This study was designed to investigate the effect of unaffected limb fatigue on balance. This study was conducted in the laboratory of isokinetic dynamometer from April 2017 to December 2017 at the Faculty of Physical Therapy, Cairo University. Twenty nine children with hemiplegic cerebral palsy were recruited from Mataria Hospital, Embaba Hospital, Abu Al-Resh Hospital and Banha Hospital. Data were collected at the outpatient Clinic of the Faculty of Physical Therapy, Cairo

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University. The study was approved by the Ethics Committee of Faculty of Physical Therapy, Cairo University, and all parents have signed written consent forms at the beginning of the study.

Patients:

Twenty nine children with hemiplegic CP (6-14yrs), were recruited from the outpatient clinic of the Faculty of Physical Therapy, Cairo University.

Inclusion criteria: Their gross motor ability was I/II according to GMFCS; spasticity was I/I + according to Modified Ashworth Scale.

Exclusion criteria: Children were excluded if they had any orthopedic surgery or botulinum toxin injections within 12 months and 6 months respectively, prior to the start of study.

Material:

Biodex balance system:

Biodex balance system (Biodex Crop. Shirley, NY) was used to assess the balance. It is a multi-axial tilting platform which allows objective evaluation of the ability of a participant to control single and double-limb postural stance on an unstable platform. It assess overall postural stability, anterior/posterior and medial/lateral stability. High score is indicative poor balance [10]. Each participant was asked to stand bear feet on the balance platform, with eyes open, and to remain as stable as possible. Video screen in front of patient for visual feedback, and the individuals attempt to keep the dot at the center of the plot. All participants were tested on stability level 7 according to a prior

pilot study. Each measurement lasted for 20 seconds [11].

Isokinetic dynamometer:

Fatigue of unaffected limb was induced using Biodex system 3 Pro Isokinetic dynamometer (Biodex Medical INC., Shirely, New York, USA). The subject sat in the Biodex chair in semi reclining position with the angle of the hip at 70 degrees. Fatigue protocol was applied at repetitions of 35° reciprocal maximal concentric contractions of knee flexion and extension, with a range of motion of 90° at an angular velocity of 60°/s [12].

Results

Twenty nine hemiplegic children of both sexes (20 boys and 9 girls) participated in this study with their mean \pm SD of ages, weights, heights and BMI were 8.9 ± 2.3 years, 26.4 ± 7.8 kg, 123.3 ± 9.1 cm and 17.1 ± 2.9 kg/m² respectively. The demographic data of the participants is shown in (Table 1).

As shown in (Table 2), there was significant difference in postural balance between pre and post-fatigue in over all, anteroposterior and mediolateral stability index ($p < 0.001$, $p = 0.003$ and $p = 0.002$) respectively.

Table (1): Demographic data of the participants.

	Mean	SD	Median	Minimum	Maximum
Age (yrs.)	8.9	2.3	9	6	14
Weight (kg)	26.4	7.8	25	16	50
Height (cm)	123.3	9.1	121	113	153
BMI (kg/m ²)	17.1	2.9	17.23	11.3	24.85

BMI: Body Mass Index.

Table (2): Biodex scoring before and after fatigue.

	Before		After		Mean difference	95% CI		Percent	
	Mean	SD	Mean	SD		Lower	Upper	Change	p-value
Over all stability index	2	0.6	2.5	0.8	0.5	0.3	0.7	24.8	<0.001
AP stability index	1.3	0.4	1.7	0.7	0.4	0.1	0.6	28.9	0.003
ML stability index	1.5	0.6	1.9	0.7	0.4	0.1	0.6	23.9	0.002

SD: Standard Deviation.

Discussion

The present study investigates the effect of induced fatigue of unaffected limb on balance in children with hemiplegic cerebral palsy. The results showed that fatigue caused deterioration of balance in both frontal and sagittal planes.

Balance performance impaired due to golgi tendon desensitization and muscle spindle desensitization or ligament relaxation occurs with fatigue

[13]. Simoneau et al., [14] examined how moderate fatigue by fast walking affected the control of balance they reported an initial negative impact on the control of balance. In addition, Miura et al., [15] and Lee et al., [16] found that the muscular fatigue induces an adverse change in the proprioception as well as postural control. Yaggie and McGregor [17] also examined the impact of lower extremity fatigue on balance indexes using the Sport-KAT-2000 system before and immediately

after the fatigue protocol. They reported that lower extremity fatigue adversely affected balance index scores, which is in agreement with the results of our current study.

Common observation is that cycling exercise, performed under intensive or prolonged modes, impairs the ability to maintain standing balance that is also confirmed my study [18,19].

Nardone et al., [20], reported that changes in the sensory proprioceptive information and their integration and decrease of the muscular system efficiency due to muscular fatigue.

Cycling exercising to fatigue, defined as a decreased force generating capacity, has been shown to reduce knee joint proprioception which is one of sensory system of balance [21]. Fatigue following various types of exercises has been found to alter balance and postural stability [22].

Conclusion:

It's concluded that fatigue of the unaffected limb in children with hemiplegic cerebral palsy impaired balance because hemiplegic children mostly depend on the unaffected limb to maintain their balance.

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تأثير الإجهاد المستحث للطرف الغير مصاب على الإتزان في أطفال الفالج الشقي

المقدمة: عادة أطفال الفالج الشقي يحملون معظم وزنهم على الطرف الغير مصاب لتعويض ضعف العضلات في الطرف المصاب مما ينتج عنه إجهاد الجزء السليم، والتأثير على الإتزان.

الهدف: لمعرفة تأثير إجهاد الطرف الغير مصاب على الإتزان في أطفال الفالج الشقي.

الأساليب والمرضى: هذه الدراسة على تسعة وعشرون طفلا من أطفال الفالج الشقي، أختيروا من العيادة الخارجية لكلية العلاج الطبيعي جامعة القاهرة، الأطفال على المستوى الأول والثاني في نظام تصنيف الوظيفية الحركية، وأعمارهم تتراوح بين السادسة والرابعة عشر عاما.

النتائج: أظهرت النتائج وجود دلالة إحصائية إيجابية من تأثير إجهاد الطرف الغير مصاب على الإتزان في أطفال الفالج الشقي.

الخلاصة: إجهاد الطرف الغير مصاب في حالات أطفال الفالج الشقي يؤثر على الإتزان.